



Driver Manual
(Supplement to the FieldServer Instruction Manual)

FS-8700-16 Bacnet PTP - Serial

APPLICABILITY & EFFECTIVITY

Effective for all systems manufactured after September 2008

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1. BACnet Description

The BACnet PTP driver allows the FieldServer to transfer data to and from devices using the BACnet protocol over a serial RS-232 physical layer. The FieldServer can emulate either a Server or Client.

The information that follows describes how to expand upon the factory defaults provided in the configuration files included with the FieldServer.

2. Driver Scope of Supply

2.1. Supplied by FieldServer Technologies for this Driver

FieldServer Technologies PART #	Description
FS-8917-02	RJ45 to DB9F Connector adapter
FS-8917-03	Connector adapter – DB9M to DCE, RTS/CTS, DSR/DTR
FS-8700-16	Driver Manual.

2.2. Provided by supplier of 3rd party equipment

PART #	DESCRIPTION
	Building control unit (BCU) ¹
	BACnet client such as a workstation ²

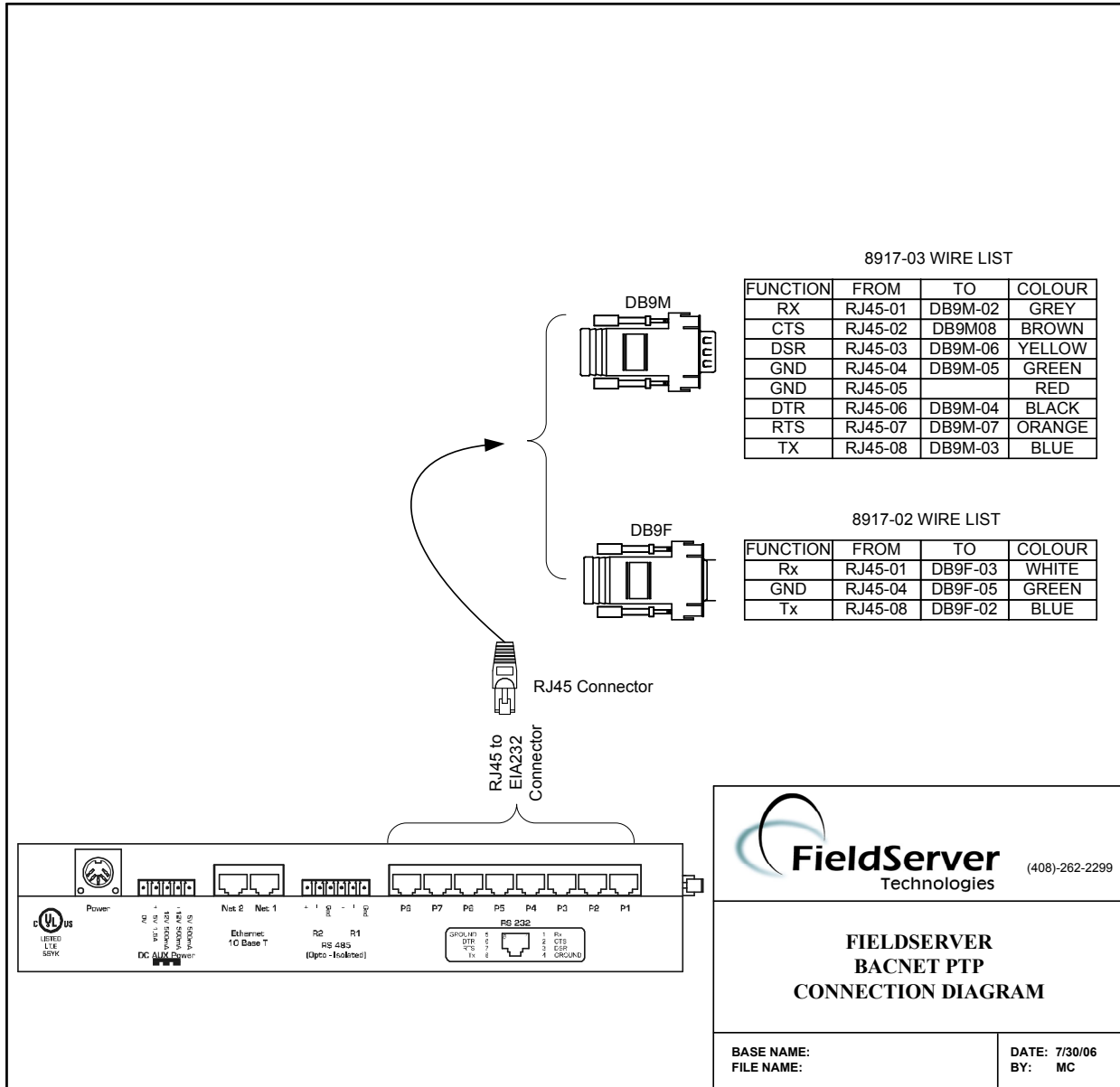
¹ If FieldServer used as BACnet Client.

² If FieldServer used as BACnet Server

3. Hardware Connections

It is possible to connect a BACnet device to any of the eight RS-232³ ports. These ports just need to be configured for BACnet in the configuration file.

Configure the PLC (or BCU) according to manufacturer's instructions



Note that connection to a Trane BCU requires the 8917-02 option.

³ Not all ports shown are necessarily supported by the hardware. Consult the appropriate Instruction manual for details of the ports available on specific hardware.

4. Configuring the FieldServer as a BACnet Client

For a detailed discussion on FieldServer configuration, please refer to the FieldServer Instruction Manual. The information that follows describes how to expand upon the factory defaults provided in the configuration files included with the FieldServer (See “.csv” sample files provided with the FieldServer).

This section documents and describes the parameters necessary for configuring the FieldServer to communicate with a BACnet Server.

4.1. Data Arrays/ Descriptors

The configuration file tells the FieldServer about its interfaces, and the routing of data required. In order to enable the FieldServer for BACnet communications, the driver independent FieldServer buffers need to be declared in the “Data Arrays” section, the destination device addresses need to be declared in the “Client Side Nodes” section, and the data required from the servers needs to be mapped in the “Client Side Map Descriptors” section. Details on how to do this can be found below.

Note that in the tables, * indicates an optional parameter, with the bold legal value being the default.

Section Title		
Data_Arrays		
Column Title	Function	Legal Values
Data_Array_Name	Provide name for Data Array	Up to 15 alphanumeric characters
Data_Format	Provides data format	Float, Bit, Uint16, Uint32, Sint16, Sint32, Packed_Bit, Byte, Packed_Byte, Swapped_Byte
Data_Array_Length	Number of Data Objects	1-10,000

Example

```
// Data Arrays
Data_Arrays
Data_Array_Name,      Data_Format,      Data_Array_Length
DA_AI_01,             Float,            200
DA_AO_01,             Float,            200
DA_DI_01,             Bit,              200
DA_DO_01,             Bit,              200
```

4.2. Setting the FieldServer Node_ID and Network Number

Section Title		
FieldServer		
Column Title	Function	Legal Values
System_Node_ID	Configure Node_ID of FieldServer	1-255
Network_Number	BACnet Network Number	1-65535, 5

Example

```
// FieldServer

FieldServer
Title,          System_Node_ID,      Network_Number
BACnet_PTP,    11,                    2
```

4.3. Client Side Connection Descriptions

Section Title		
Connections		
Column Title	Function	Legal Values
Port	Port Name	P1-P8 ⁴
Baud*	Specify baud rate	110; 300; 600; 1200; 2400; 4800; 9600 ; 19200; 38400; 57600; 115000
Parity*	Specify parity	Odd, Even, None
Data_Bits*	Specify data bits	7, 8
Stop_Bits*	Specify stop bits	1,2
Protocol	Specify Protocol Used	BACnet_PTP

Example

```
// Client Side Connections

Connections
Port,      Baud,      Parity,      Data_Bits,      Stop_Bits,      Protocol
P8,        9600,      Even,        7,              1,              BACnet_PTP
```

4.4. Client Side Node Descriptors

Section Title		
Nodes		
Column Title	Function	Legal Values
Node_Name	Provide name for node	Up to 32 alphanumeric characters
Node_ID	Node ID of physical server node (the BCU)	1 - 4194303
Protocol	Specify protocol used	BACnet_PTP
Port	Specify port	P1-P8 ⁵

Example

```
// Client Side Nodes

Nodes
Node_Name,      Node_ID,      Protocol,      Port
BCU_1,          1,           BACnet_PTP,   P8
```

⁴ Not all ports shown are necessarily supported by the hardware. Consult the appropriate Instruction manual for details of the ports available on specific hardware.

⁵ Not all ports shown are necessarily supported by the hardware. Consult the appropriate Instruction manual for details of the ports available on specific hardware.

4.5. Client Side Map Descriptors

4.5.1. FieldServer Related Map Descriptor Parameters

Column Title	Function	Legal Values
Map_Descriptor_Name	Name of this Map Descriptor	Up to 32 alphanumeric characters
Data_Array_Name	Name of Data Array where data is to be stored in the FieldServer	One of the Data Array names from "Data Array" section above
Data_Array_Offset	Starting location in Data Array	0 to maximum specified in "Data Array" section above
Function	Function of Client Map Descriptor	RDBC, WRBC, WRBX

4.5.2. Driver Related Map Descriptor Parameters

Column Title	Function	Legal Values
Node_Name	Name of Node to fetch data from	One of the node names specified in "Client Node Descriptor" above
Data_Type	Data type in FieldServer	AI, AO, AV, BI, BV, MI, MO, MV ⁶
Object_Instance	Address of object	0, 1, 2, 3, ...
Property*	The BACnet property to be read	Present_Value
Data_Array_Low_Scale*	Scaling zero in Data Array	-32767 to 32767, 0
Data_Array_High_Scale*	Scaling max in Data Array	-32767 to 32767, 100
Node_Low_Scale*	Scaling zero in Connected Node	-32767 to 32767, 0
Node_High_Scale*	Scaling max in Connected Node	-32767 to 32767, 100
Length*	Number of objects that will be polled using the READ_PROPERTY_MULTIPLE service. See Appendix B.3	2-29, 1
Write_Priority*	Allows the driver to specify the write priority used to write an output. See also Appendix B.2	1..16, 16
Custom_Type	This over-writes the Data_Type with a numerical value for the Data_Type. e.g. Analog Value = 2	1..1023
Custom_Prop	This over-writes the Property with a numerical value for the property. e.g. Present Value = 85	1..4194303

4.5.3. Timing Parameters

Column Title	Function	Legal Values
Scan_Interval*	Seconds per scan	0-32000, 2

⁶ Refer to Appendix A.1 for further information.

4.5.4. Map Descriptor Example

```
// Client Side Map Descriptors
```

Map_Descriptor_Name,	Data_Array_Name,	Data_Array_Offset,	Function,	Node_Name,	Data_Type,	Object_Instance	Property,	Scan_Interval
Map_Descriptors CMD_AI_01,	DA_AI_01,	0,	RDBC,	BCU_1,	AI,	1,	Present_Value,	20.000s
CMD_AI_02,	DA_AI_01,	1,	RDBC,	BCU_1,	AI,	2,	Present_Value,	20.000s
CMD_AI_03,	DA_AI_01,	2,	RDBC,	BCU_1,	AI,	3,	Present_Value,	20.000s
CMD_AO_01,	DA_AO_01,	0,	RDBC,	BCU_1,	AO,	1,	Present_Value,	30.000s
CMD_AO_02,	DA_AO_01,	1,	RDBC,	BCU_1,	AO,	2,	Present_Value,	30.000s
CMD_AO_03,	DA_AO_01,	2,	RDBC,	BCU_1,	AO,	3,	Present_Value,	30.000s
Map_Descriptors								
Map_Descriptors CMD_DI_01,	DA_DI_01,	0,	Function,	Node_Name,	Data_Type,	Object_Instance,	Property,	Scan_Interval
CMD_DI_02,	DA_DI_01,	1,	RDBC,	BCU_1,	DI,	1,	Present_Value,	15.000s
CMD_DI_03,	DA_DI_01,	2,	RDBC,	BCU_1,	DI,	2,	Present_Value,	15.000s
CMD_DO_01,	DA_DO_01,	0,	RDBC,	BCU_1,	DO,	1,	Present_Value,	30.000s
CMD_DO_02,	DA_DO_01,	1,	RDBC,	BCU_1,	DO,	2,	Present_Value,	30.000s
CMD_DO_03,	DA_DO_01,	2,	RDBC,	BCU_1,	DO,	3,	Present_Value,	30.000s

5. Configuring the FieldServer as a BACnet Server

For a detailed discussion on FieldServer configuration, please refer to the FieldServer Configuration Manual. The information that follows describes how to expand upon the factory defaults provided in the configuration files included with the FieldServer (See “.csv” sample files provided with the FieldServer).

This section documents and describes the parameters necessary for configuring the FieldServer to communicate with a BACnet Client.

The configuration file tells the FieldServer about its interfaces, and the routing of data required. In order to enable the FieldServer for BACnet communications, the driver independent FieldServer buffers need to be declared in the “Data Arrays” section, the FieldServer virtual node(s) needs to be declared in the “Server Side Nodes” section, and the data to be provided to the clients needs to be mapped in the “Server Side Map Descriptors” section. Details on how to do this can be found below.

Note that in the tables, * indicates an optional parameter, with the bold legal value being the default.

5.1. Driver Specific FieldServer Parameters

Section Title		
Bridge		
Column Title	Function	Legal Values
Title	FieldServer name	Text
Network_number*	Specify a unique network number if there are multiple virtual Server nodes.	1-65535 5

Example

// FieldServer Driver specific parameters		
Bridge		
Title,	Network_number	
Bacnet Server,	6	

5.2. Server Side Connection Descriptions

Section Title		
Connections		
Column Title	Function	Legal Values
Port	Port name	P1-P8 ⁷
Baud*	Specify baud rate	110; 300; 600; 1200; 2400; 4800; 9600 ; 19200; 38400; 57600; 115000
Parity*	Specify parity	Odd, Even, None
Data_Bits*	Specify data bits	7, 8
Stop_Bits*	Specify stop bits	1,2
Protocol	Specify Protocol Used	BACnet_PTP

Example

```
// Server Side Connections

Connections
Port,           Baud,  Parity,  Data_Bits,  Stop_Bits,  Protocol
P1,             9600,  Even,    7,          1,          BACnet_PTP
```

5.3. Server Side Node Descriptors

Section Title		
Nodes		
Column Title	Function	Legal Values
Node_Name ⁸	Provide name for node	Up to 32 alphanumeric characters
Node_ID	BACnet station address of physical Server node	1 - 4194303
Protocol	Specify protocol used	BACnet_PTP

Example

```
// Server Side Nodes

Nodes
Node_Name,           Node_ID,           Protocol
Virtual_BCU_11,     11,               BACnet_PTP
```

⁷ Not all ports shown are necessarily supported by the hardware. Consult the appropriate Instruction manual for details of the ports available on specific hardware.

⁸ When using the Trane Tracer Summit Workstation System, this name will appear as the object name

5.4. Server Side Map Descriptors

5.4.1. FieldServer Specific Map Descriptor Parameters

Column Title	Function	Legal Values
Map_Descriptor_Name	Name of this Map Descriptor	Up to 32 alphanumeric characters.
Data_Array_Name	Name of Data Array where data is to be stored in the FieldServer	One of the Data Array names from "Data Array" section
Data_Array_Offset	Starting location in Data Array	0 to data_array_length-1 as specified in "Data Array" section
Function	Function of Server Map Descriptor	Server

5.4.2. Driver Specific Map Descriptor Parameters

Column Title	Function	Legal Values
Node_Name	Name of FieldServer Node	One of the node names specified in "Server Node Descriptor" above
Data_Type	Data type in BCU	AI, AO, AV, BI, BV, MI, MO, MV ⁹
Object_Instance	Address of the object	0, 1, 2, 3, ...
Units	The object units	See Appendix D
Data_Array_Low_Scale*	Scaling zero in Data Array	-32767 to 32767, 0
Data_Array_High_Scale*	Scaling max in Data Array	-32767 to 32767, 100
Node_Low_Scale*	Scaling zero in Connected Node	-32767 to 32767, 0
Node_High_Scale*	Scaling max in Connected Node	-32767 to 32767, 100
Active Text	Specify the Active Text property of the Object	Any legal BACnet ASCII string
Inactive Text	Specify the Inactive Text property of the	Any legal BACnet ASCII string
Relinquish Default	Specify the startup Relinquish_Default Property value for this Object	Any legal BACnet ASCII string
Custom_Type	This over-writes the Data_Type with a numerical value for the Data_Type. e.g. Analog Value = 2	1..1023
Custom_Prop	This over-writes the Property with a numerical value for the property. e.g. Present Value = 85	1..4194303

⁹ Refer to Appendix A.1 for further information.

5.4.3. Map Descriptor Example

```
// Server Side Map Descriptors
```

Map_Descriptors Name_	Data_Array_ Name_	Data_Array_ Offset	Function,	Node_Name,	Data_Type	Object_ Instance,	Property,	Units,	Data_Array_ Low_Scale,	Data_Array_ High_Scale,	Node_ Low_Scale,	Node_ High_Scale
SMD_AI_01,	DA_AI_01,	0,	Server,	Virtual_BCU_11,	AI,	1,	Present_Value,	Deg_F,	0,	10000,	0,	100
SMD_AI_02,	DA_AI_01,	1,	Server,	Virtual_BCU_11,	AI,	2,	Present_Value,	Deg_F,	0,	10000,	0,	100
SMD_AI_03,	DA_AI_01,	2,	Server,	Virtual_BCU_11,	AI,	3,	Present_Value,	Deg_F,	0,	10000,	0,	100
SMD_AO_01,	DA_AO_01,	0,	Server,	Virtual_BCU_11,	AO,	1,	Present_Value,	%RH,	0,	10000,	0,	100
SMD_AO_02,	DA_AO_01,	1,	Server,	Virtual_BCU_11,	AO,	2,	Present_Value,	%RH,	0,	10000,	0,	100
SMD_AO_03,	DA_AO_01,	2,	Server,	Virtual_BCU_11,	AO,	3,	Present_Value,	%RH,	0,	10000,	0,	100

Map_Descriptors Map_Descriptor_Name,	Data_Array_Name,	Data_Array_Offset,	Function,	Node_Name,	Data_Type,	Object_Instance,	Property,	Units,	Data_Array_Low_Scale,	Data_Array_High_Scale,	Node_Low_Scale,	Node_High_Scale
SMD_DI_01,	DA_DI_01,	0,	Server,	Virtual_BCU_11,	DI,	1,	Present_Value					
SMD_DI_02,	DA_DI_01,	1,	Server,	Virtual_BCU_11,	DI,	2,	Present_Value					
SMD_DI_03,	DA_DI_01,	2,	Server,	Virtual_BCU_11,	DI,	3,	Present_Value					
SMD_DO_01,	DA_DO_01,	0,	Server,	Virtual_BCU_11,	DO,	1,	Present_Value					
SMD_DO_02,	DA_DO_01,	1,	Server,	Virtual_BCU_11,	DO,	2,	Present_Value					
SMD_DO_03,	DA_DO_01,	2,	Server,	Virtual_BCU_11,	DO,	3,	Present_Value					

Appendix A. Driver Notes

Appendix A.1. Data_Type Legal Values – Abbreviation Descriptions

AI ANALOG_INPUT
AO ANALOG_OUTPUT
AV ANALOG_VALUE
BI BINARY_INPUT
BV BINARY_VALUE
MI MULTI_STATE_INPUT
MO MULTI_STATE_OUTPUT
MV MULTI_STATE_VALUE

Appendix B. Advanced Topics

Appendix B.1. BACnet Object Names

When an external BACnet Client builds a list of Object Names, the BACnet Server Map Descriptor name determines the BACnet Object Name. If the Map Descriptor length is greater than 1, then the Object Name will be suffixed with the index into the Map Descriptor. For example, if the Map Descriptor name is SMD_AI_01 and the length 3, then the Object Names will be SMD_AI_01[0], SMD_AI_01[1] and SMD_AI_01[2].

Appendix B.2. BACnet Priority Arrays

FieldServer implementation of BACnet priority Arrays

When BACnet Output objects are written to the Server side of the FieldServer, an associated write priority is given to each write value. When the FieldServer receives the write value, it will be stored to the Map Descriptor Priority Array Table at the specified priority. The Priority Array Table is then scanned and the value with the highest priority is stored to the Data Array location specified by the Map Descriptor.

When a Write “Relinquished” command is received, the value is removed from the Priority Array Table and the next highest value from the Priority Array Table is stored to the Data Array.

If all values have been “Relinquished” from the Priority Array Table, then the Map Descriptors “Relinquish Default” value will be stored to the Data Array.

Accessing Priority Array information

The Priority Array table and its “In_Use” (or Not Relinquished) state are stored internally to every Map Descriptor, and cannot be accessed directly. If the following data arrays are specified, however, they will maintain an exact copy of the Priority Array Table for the Map Descriptor. Thus the Priority Array Table can be accessed.

Section Title		
Map Descriptors		
Column Title	Function	Legal Values
DA_Pri_Array	Name of Data Array where the Priority Array Table will be stored. Location 0 is the Relinquish Default value and locations 1 to 16 the different entries of the Priority Array Table.	Up to 16 alphanumeric characters
DA_Pri_Array_Offset	Starting location in Data Array.	1-65535, 17
DA_Pri_In_Use	Name of Data Array that indicates if a particular Priority Value is in use. Location 0 indicates whether the Relinquish Default has been set and locations 1 to 16 indicate whether the index is in use (1), or Relinquished (0).	Up to 16 alphanumeric characters
DA_Pri_In_Use_Offset	Starting location in Data Array.	1-65535, 17

Appendix B.3. Limitations of the BACnet READ_PROPERTY_MULTIPLE service.

The BACnet PTP client driver can read multiple BACnet objects using the READ_PROPERTY_MULTIPLE service under the following conditions:

- The number of objects to be read must not exceed 29.
- No gaps must exist in the range of object to be read.
- The Map Descriptor function must be of the READ type. (e.g. RDBC)
- The Map Descriptor property must be Present Value.

Appendix B.4. Network number

The default Network number of a FieldServer is 5. In order to ensure communication between the BACnet Client and all Servers on a BACnet network, however, it may be necessary to assign a unique network number to each FieldServer.

A unique network number will need to be assigned if *both* of the following conditions are true:

- The FieldServer has multiple BACnet Server nodes.
- There is more than one FieldServer on a network which includes multiple BACnet nodes.

To override the FieldServer's default network number 5, refer to Section 5.1

Appendix B.5. BACnet State Text Preload

Method 1 – Using a Single Data Array:

```
Data_Arrays
Data_Array_Name, Data_Format, Data_Array_Length
DA_MI_01,      UINT16,      100
DA_STATE_TXT, BYTE,      200
```

```
Preloads
Data_Array_Name, Preload_Data_Value, Preload_Data_Format, Preload_Data_Index
DA_STATE_TXT,   MyState1 MyState2 MyState3 MyState4 MyState5 MyState6, STRING, 0
```

```
Map_Descriptors
Map_Descriptor_Name, Data_Type, Object_ID, Function, Data_Array_Name, Data_Array_Index, Node_Name, Length, State_Text_Array
CMD_MI_01,          MI,          1,          Server, DA_MI_01, 0, N1 11, 1, DA_STATE_TXT
```

Method 2 – Using an Offset/User Table:

```
//set up a look up table
Offset_Table,
Offset_Table_Name, Table_String, Table_Index_Value
FIRE_ALARM_TEXT, SYSTEM READY, 0
FIRE_ALARM_TEXT, ALARM, 1
FIRE_ALARM_TEXT, MAINTENANCE, 2
FIRE_ALARM_TEXT, OFF-LINE, 3
FIRE_ALARM_TEXT, IN SERVICE, 4
FIRE_ALARM_TEXT, OTHER, 5
```

```
Data_Arrays
Data_Array_Name, Data_Format, Data_Array_Length
DA_MI_01,      UINT16,      100
```

```
Map_Descriptors
Map_Descriptor_Name, Data_Type, Object_ID, Function, Data_Array_Name, Data_Array_Index, Node_Name, Length, State_Text_Array
CMD_MI_01,          MI,          1,          Server, DA_MI_01, 1, N1 11, 1, FIRE_ALARM_TEXT
```


Appendix C. Troubleshooting Tips

Appendix C.1. Debugging a BACnet connection – Hints and Tips

- Disconnect the FieldServer from the BACnet network when transferring images to the BCU.
- If duplicate object instances are accidentally configured in the FieldServer, the second call of the instance will overwrite the first one. This may cause a BACnet Object to be “lost.”
- If “Virtual_BCU_...” is not being indicated as the device description for the FieldServer on the BACnet SCADA system, then the FieldServer is not communicating with the SCADA system. If the present value’s name is being indicated, but the present value shows question marks, then it is most likely that the Client side of the FieldServer is not communicating.
- When new points are added to the FieldServer it is important to restart the Summit Workstation or BCU, otherwise these new points may not be seen by the FieldServer.
- Polling BACnet addresses that are not configured for Lieberts systems may cause the connection to fail in older versions of Lieberts. Please contact your Lieberts supplier for more information.
- When a BACnet_PTP connection is established, and the connection is broken abruptly (for instance a power down), the BCU might not know immediately that this happened. If the FieldServer is the powered up again, it might take several seconds (up to 60 seconds) before polling will start again.
- Extra memory is required to store Map Descriptors that have the active/inactive text parameters specified. If the defaults are appropriate, do not specify these parameters. This will save memory and allow more Map Descriptors to be created
- **McQuay Units** are shipped with a default Device instance of the last 6 digits of the McQuay Serial number.

Trane Specific Tips

- When new points are added to the FieldServer it is important to restart Summit Workstation or BCU, otherwise these new points may not be seen by the FieldServer.
- Disconnect the FieldServer from the BACnet network when transferring images to the BCU

Appendix C.2. BACnet Specific Statistics

Stat	Description	Resolution
Link Control	A who-is link control message was send or received.	It is normal to receive a few link control messages. If the number is higher than the transmit/receive messages, there may be a problem with lost communications.
Unsupported Properties	A request for an unsupported property was received.	This is not an error. BACnet clients often poll all properties of a particular object to determine which properties are supported.
Segmentation Not Supported	Data was requested but the response would have exceeded the maximum size of the APDU and could not be sent using an un-segmented message.	This is not an error - the BACnet client will use a different method to read data from the FieldServer.
Sequence Error	Invoke ID of a reply did not match the Invoke ID of the poll.	You should not see this message. It normally indicates a configuration error.
Write Access Denied	Writing to an object was denied.	This typically happens when trying to write to an Input Object that is not Out-Of-Service. It is not possible to write to Input Objects.
Exception Errors	A BACnet Service was denied because it is not supported	This may be a problem on the Client system. Consult the PIC statement to determine what services are supported.

Appendix D. Units

Unit	Variation 1	Variation 2	Variation 3
Amperes	Amps	A	
Bars			
BTUs			
BTUs-per-hour			
btus-per-pound			
btus-per-pound-dry-air			
centimeters			
centimeters-of-mercury			
centimeters-of-water			
cubic-feet			
cubic-feet-per-minute			
cubic-feet-per-seconds			
cubic-meters			
cubic-meters-per-hour			
cubic-meters-per-seconds			
Currency1			
Currency2			
Currency3			
Currency4			
Currency5			
Currency6			
Currency7			
Currency8			
Currency9			
Currency10			
cycles-per-hour			
cycles-per-minute			
days			
degrees-angular			
Degrees-Celsius	Deg-C	Deg_C	
degrees-celsius-per-hour			
degrees-celsius-per-minute			
Degrees-days-Celsius			
Degrees-days-Fahrenheit			
Degrees-Fahrenheit	Deg-F	Deg_F	
degrees-fahrenheit-per-hour			
degrees-fahrenheit-per-minute			
Degrees-Kelvin	Deg-K	Deg_K	
degrees-phase			
delta-degrees-fahrenheit			
delta-degrees-kelvin			
feet			
feet-per-minute			
feet-per-second			
foot-candles			
grams-water-per-kg-dry-air			
hectopascals			
Hertz	Hz		
Horsepower	HP		
hours			

Unit	Variation 1	Variation 2	Variation 3
imperial-gallons			
imperial-gallons-per-min			
inches			
inches-of-mercury			
inches-of-water			
Joules			
joules-per-degree-kelvin			
joules-per-kilogram-degree-kelvin			
joules-per-kilogram-dry-air			
Kilograms	Kg		
kilograms-per-hour			
kilograms-per-minute			
kilograms-per-second			
Kilohertz	KHz		
kilohms			
Kilojoules			
kilojoules-per-kilogram			
kilometers-per-hour			
Kilopascals	KPa		
kilovolt-amperes	kilovolt-amps	KVA	
kilovolt-amperes-reactive	KVAR		
kilovolts			
kilowatt-hour-per-square-foot			
kilowatt-hour-per-square-meter			
kilowatt-hours	KWh		
kilowatts	KW		
liters			
liters-per-hour			
liters-per-minute			
liters-per-second			
lumens			
luxes			
Megahertz	MHz		
megajoules			
megajoules-per-square-foot			
megajoules-per-square-meter			
megavolt-amperes	megavolt-amps		
Megavolt-amperes-reactive	MVAR		
megavolts			
megawatts	MW		
megohms			
meters			
meters-per-second			
miles-per-hour			
milliamperes	milliamps		
millibars			
millimeters			
millimeters-of-mercury			
Millivolts			
Milliwatts			
minutes			
months			

Unit	Variation 1	Variation 2	Variation 3
No-Units	No Units	No_Units	None
ohms			
parts-per-billion			
parts-per-million			
Pascals			
Percent			
percent-obscuration-per-foot			
percent-obscuration-per-meter			
percent-per-second			
percent-relative-humidity	% RH; %RH	Percent RH;	PercentRH
Per-hour			
per-minute			
per-second			
pounds-force-per-square-inch	PSI	pounds-force-per-sq-inch	
Pounds-mass			
pounds-mass-per-hour			
pounds-mass-per-minute			
pounds-mass-per-second			
Power-Factor	PF		
psi-per-degrees-fahrenheit			
radians			
revolutions-per-minute			
seconds	Secs	S	
square-centimeters			
square-feet			
square-inches			
square-meters			
Therms			
ton-hours			
Tons			
Tons-refrigeration			
US-gallons	Gallons		
us-gallons-per-minute	GPM		
Volt-Amperes	Volt-Amps	VA	
volt-amperes-reactive	VAR		
Volts	Voltage		
watt-hours	Wh		
Watts	W		
watts-per-square-foot			
watts-per-square-meter			
watts-per-square-meter-degrees-kelvin			
weeks			
years			